

Table S1. The hub genes in Turquoise module and Light cyan module and 67 hub genes related to lung metastasis coming from unit of Turquoise module and Light cyan module.

Turquoise module hub genes	Light cyan module hub genes	67 hub genes
AP2S1	ARF5	ARF5
ARPC4	ATP5MF	ATP5MF
ATP5MC2	ATP6V1F	FASTK
ATP6V1F	FASTK	PDAP1
BCL7C	PDAP1	POLR2J
BRK1	POLR2J	SSBP1
CCDC12	PTGES2	AP2S1
CD2BP2	SSBP1	ARPC4
CIB1		ATP5MC2
COMMD4		ATP6V1F
CSNK2B		BCL7C
DYNLRB1		BRK1
EXOSC5		CCDC12
FBL		CD2BP2
FKBP1A		CIB1
HCFC1R1		COMMD4
HRAS		CSNK2B
IMP4		DYNLRB1
MRPL14		EXOSC5
MRPL17		FBL
MRPS26		FKBP1A
MZT2A		HCFC1R1
MZT2B		HRAS
NDUFB11		IMP4
NEDD8		MRPL14
NME1		MRPL17
NOP10		MRPS26
NOSIP		MZT2A
NSUN5		MZT2B
NUTF2		NDUFB11
PFDN5		NEDD8
PLPP3		NME1
PMF1		NOP10
POLR2H		NOSIP
POLR2L		NSUN5
PSENEN		NUTF2
PTGES2		PFDN5
PTRH2		PLPP3
RALY		PMF1
RPL14		POLR2H
RPL18		POLR2L
RPL24		PSENEN
RPL27A		PTGES2
RPL32		PTRH2
RPL35A		RALY
RPL37		RPL14
RPL38		RPL18
RPLP1		RPL24

RPLP2	RPL27A
RPS11	RPL32
RPS15	RPL35A
RPS16	RPL37
RUVBL2	RPL38
SERF2	RPLP1
SNRPA	RPLP2
SNU13	RPS11
SSNA1	RPS15
TAF10	RPS16
TIMM17B	RUVBL2
TMEM101	SERF2
TRIR	SNRPA
	SNU13
	SSNA1
	TAF10
	TIMM17B
	TMEM101
	TRIR

Table S2. The expression of 67 genes between normal liver tissues and hepatocellular carcinoma tissues.

Genes	Normal Number	Tumor Number	Normal Mean	Tumor Mean	P
AP2S1	47	370	4.236174053	4.743848669	1.63E-16
ARF5	47	370	4.327995933	4.883097398	2.92E-18
ARPC4	47	370	3.512863813	4.078881997	1.23E-17
ATP5MC2	47	370	4.262816387	4.930182324	1.60E-22
ATP5MF	47	370	3.979963092	4.843541589	5.63E-26
ATP6V1F	47	370	4.293143721	5.20576096	2.62E-24
BCL7C	47	370	2.118654266	2.81385153	5.00E-19
BRK1	47	370	4.791267292	5.283072575	6.96E-18
CCDC12	47	370	2.349026338	2.886978	1.57E-17
CD2BP2	47	370	2.673408624	3.475962989	9.08E-22
CIB1	47	370	4.902221447	5.286295675	6.40E-11
COMMD4	47	370	2.459161885	3.378739607	4.40E-26
CSNK2B	47	370	3.228806047	4.018508935	2.23E-22
DYNLRB1	47	370	3.557521366	4.439422499	2.68E-25
EXOSC5	47	370	2.831487938	3.685862191	8.82E-23
FASTK	47	370	3.177448077	4.080366239	2.47E-25
FBL	47	370	3.766325498	4.686045005	5.37E-22
FKBP1A	47	370	3.993354956	4.779695157	1.75E-22
HCFC1R1	47	370	3.09895519	3.848124907	1.22E-20
HRAS	47	370	2.462832492	3.435088809	6.42E-25
IMP4	47	370	3.162838782	3.641644946	7.75E-19
MRPL14	47	370	4.55426441	5.202250606	2.49E-18
MRPL17	47	370	2.907411014	3.614999108	5.51E-22
MRPS26	47	370	4.232530675	4.773164023	1.02E-16
MZT2A	47	370	2.303094184	2.946016908	4.84E-14
MZT2B	47	370	3.88218848	4.412230407	1.94E-12
NDUFB11	47	370	4.780598304	5.245927222	1.47E-13
NEDD8	47	370	2.975431022	3.658874492	6.68E-25
NME1	47	370	2.566431934	3.668551938	6.41E-24

NOP10	47	370	4.974046135	5.556391615	4.43E-20
NOSIP	47	370	2.597752906	3.241833468	1.81E-19
NSUN5	47	370	2.008022182	2.987134009	4.53E-25
NUTF2	47	370	2.95722181	3.686968526	1.14E-23
PDAP1	47	370	3.629840729	4.352080924	1.21E-25
PFDN5	47	370	4.32326544	4.858788929	1.96E-17
PLPP3	47	370	4.401122088	3.636643709	1.03E-13
PMF1	47	370	2.754207444	3.616879903	5.24E-22
POLR2H	47	370	2.701028445	3.428003316	2.34E-22
POLR2J	47	370	3.656717386	4.335845913	2.30E-21
POLR2L	47	370	4.683328546	5.390286645	1.64E-20
PSENNEN	47	370	3.27931317	3.883106072	1.08E-18
PTGES2	47	370	2.904104984	3.682680475	3.55E-22
PTRH2	47	370	1.960294131	2.66144024	1.69E-21
RALY	47	370	2.682623331	3.588081996	1.65E-25
RPL14	47	370	4.087396049	4.802851689	3.03E-19
RPL18	47	370	4.98737278	5.66695777	7.31E-17
RPL24	47	370	5.31528629	5.888534047	4.96E-15
RPL27A	47	370	4.574013722	5.206954748	5.54E-16
RPL32	47	370	5.301494139	5.946566872	8.16E-15
RPL35A	47	370	4.76989948	5.507470459	1.75E-19
RPL37	47	370	4.381715346	5.144606041	4.43E-20
RPL38	47	370	4.411329953	5.312217286	3.69E-22
RPLP1	47	370	5.774536234	6.615128266	6.65E-22
RPLP2	47	370	5.647896973	6.458490313	1.81E-19
RPS11	47	370	6.536125455	7.208685787	2.70E-18
RPS15	47	370	4.779601931	5.460213091	5.95E-17
RPS16	47	370	5.543713865	6.321576168	4.17E-20
RUVBL2	47	370	3.191600964	3.966654395	4.32E-24
SERF2	47	370	4.480006043	5.105189806	3.79E-20
SNRPA	47	370	2.889018825	3.823946285	4.65E-26
SNU13	47	370	3.670046745	4.348472223	2.17E-22
SSBP1	47	370	2.666161325	3.30996936	8.43E-24
SSNA1	47	370	3.749301352	4.537302589	5.11E-22
TAF10	47	370	2.427629707	3.233120617	3.26E-26
TIMM17B	47	370	2.946945636	3.712441939	9.73E-24
TMEM101	47	370	2.43906996	3.408766207	6.86E-25
TRIR	47	370	4.960609885	5.204161076	7.26E-06

normal: normal liver tissues. tumor: hepatocellular carcinoma tissues. Statistical analysis: Wilcoxon rank sum test. Mean: log (TPM+1).

Table S3. The expression of 67 genes between hepatocellular carcinoma tissues without metastasis and hepatocellular carcinoma tissues with lung metastasis.

Genes	Non Number	Met Number	Non Mean	Met Mean	P
ARF5	13	18	4.570005153	5.042063047	0.000353
ARPC4	13	18	3.867000476	4.187036753	0.0138
ATP5MC2	13	18	4.720339159	5.123867245	0.00365
ATP5MF	13	18	4.611469347	4.995937259	0.0247
ATP6V1F	13	18	4.868319527	5.414773443	0.00233
AP2S1	13	18	4.541733219	4.893841487	0.0564
BCL7C	13	18	2.507078455	3.072101564	0.00315
BRK1	13	18	5.105341375	5.371575494	0.0175
CCDC12	13	18	2.643539156	3.020931865	0.0221

CD2BP2	13	18	3.229942997	3.60019467	0.0197
CIB1	13	18	5.014628908	5.586124327	6.66E-05
COMMD4	13	18	3.185341715	3.597329975	0.0156
CSNK2B	13	18	3.784803156	4.327940775	0.0156
DYNLRB1	13	18	4.200194269	4.652276939	0.0247
EXOSC5	13	18	3.367956056	3.895556975	0.0156
FASTK	13	18	3.748866306	4.285815525	6.66E-05
FBL	13	18	4.318137339	4.830185251	0.0138
FKBP1A	13	18	4.550502823	4.848077468	0.0512
HCFC1R1	13	18	3.63991686	4.119581873	0.0122
HRAS	13	18	3.156390634	3.61431002	0.0512
IMP4	13	18	3.45862231	3.781152885	0.00951
MRPL14	13	18	5.024049492	5.541494188	0.0197
MRPL17	13	18	3.325408211	3.912309672	0.00365
MRPS26	13	18	4.509144071	4.850307112	0.0197
MZT2A	13	18	2.662547912	3.188033805	0.0122
MZT2B	13	18	4.063435369	4.654737502	0.00123
NDUFB11	13	18	5.023454614	5.458779467	0.0138
NEDD8	13	18	3.450410073	3.762364605	0.0122
NME1	13	18	3.332932294	3.910559124	0.0175
NOP10	13	18	5.385986629	5.801504318	0.0156
NOSIP	13	18	3.045587338	3.405222231	0.062
NSUN5	13	18	2.77759885	3.170719105	0.00233
NUTF2	13	18	3.493825926	3.812083437	0.0156
PDAP1	13	18	4.148651301	4.407911099	0.0138
PFDN5	13	18	4.650344099	4.980768055	0.0156
PLPP3	13	18	3.918602329	3.22101653	0.0122
PMF1	13	18	3.340291981	3.941336975	0.0138
POLR2H	13	18	3.25260968	3.650255739	0.0197
POLR2J	13	18	4.044241308	4.478988521	0.0122
POLR2L	13	18	5.148515762	5.552215515	0.00951
PSENEN	13	18	3.593537592	4.08091174	0.0017
PTGES2	13	18	3.376898098	3.818746055	0.0138
PTRH2	13	18	2.473991838	2.94878903	0.0175
RALY	13	18	3.391126471	3.754746032	0.0307
RPL14	13	18	4.533568365	4.96338156	0.00835
RPL18	13	18	5.33352164	5.866520285	0.00271
RPL24	13	18	5.612584833	6.03869918	0.00365
RPL27A	13	18	4.985306181	5.482903655	0.00835
RPL32	13	18	5.662555965	6.104706371	0.00732
RPL35A	13	18	5.2403584	5.659651209	0.0138
RPL37	13	18	4.833223546	5.311903917	0.0017
RPL38	13	18	4.990707614	5.518120271	0.00835
RPLP1	13	18	6.338282882	6.858418654	0.00315
RPLP2	13	18	6.166598336	6.704891944	0.00835
RPS11	13	18	6.9565856	7.412949111	0.0108
RPS15	13	18	5.167375937	5.652052976	0.00732
RPS16	13	18	6.020542409	6.402853846	0.0138
RUVBL2	13	18	3.726873226	4.096748552	0.0197
SERF2	13	18	4.88596157	5.38366832	0.00365
SNRPA	13	18	3.523485441	3.950776983	0.0247
SNU13	13	18	4.15547317	4.523124207	0.0276
SSBP1	13	18	3.108569266	3.386831786	0.0342

SSNA1	13	18	4.210373035	4.636069975	0.0138
TAF10	13	18	3.056271973	3.479408001	0.00271
TIMM17B	13	18	3.476594046	3.978728866	0.00315
TMEM101	13	18	3.068256891	3.539063345	0.0221
TRIR	13	18	4.938279043	5.345218226	0.00199

non: hepatocellular carcinoma tissues without metastasis. met: hepatocellular carcinoma tissues with lung metastasis. Statistical analysis: Wilcoxon rank sum test. Mean: log (TPM+1).

Table S4. 53 genes correlated to FBL with absolute coefficient > 0.4 in TCGA, GSE14520 and PDC000198.

gene1	gene2	TCGA			GSE14520			PDC000198		
		cor_r	P value	FDR	cor_r	pvalue	FDR	cor_r	P value	FDR
FBL	ACADL	-0.565	1.52E-36	1.40E-35	-0.521	1.30E-18	2.30E-16	-0.426	1.13E-08	2.41E-07
FBL	ALDH9A1	-0.420	2.98E-19	1.07E-18	-0.464	1.34E-14	9.88E-13	-0.463	3.74E-10	1.20E-08
FBL	ALDOB	-0.481	1.48E-25	7.57E-25	-0.433	1.02E-12	4.90E-11	-0.554	1.17E-14	9.35E-13
FBL	APEX1	0.601	2.61E-42	3.41E-41	0.533	1.63E-19	3.43E-17	0.403	8.15E-08	1.36E-06
FBL	ATIC	0.719	1.38E-67	7.66E-66	0.533	1.44E-19	3.13E-17	0.444	2.27E-09	5.72E-08
FBL	BYSL	0.621	6.60E-46	1.07E-44	0.423	3.81E-12	1.56E-10	0.563	3.44E-15	3.05E-13
FBL	BZW2	0.585	1.42E-39	1.57E-38	0.546	1.49E-20	3.55E-18	0.528	3.33E-13	2.04E-11
FBL	CPSF6	0.502	5.40E-28	3.16E-27	0.479	1.48E-15	1.44E-13	0.500	7.69E-12	3.50E-10
FBL	DAO	-0.465	8.52E-24	3.93E-23	-0.500	4.72E-17	6.23E-15	-0.453	9.81E-10	2.76E-08
FBL	DDX50	0.517	7.62E-30	4.94E-29	0.463	1.55E-14	1.12E-12	0.482	5.40E-11	2.13E-09
FBL	EIF3D	0.744	1.38E-74	1.12E-72	0.609	1.68E-26	7.46E-24	0.449	1.43E-09	3.83E-08
FBL	EIF3E	0.562	5.13E-36	4.58E-35	0.472	4.41E-15	3.82E-13	0.483	5.23E-11	2.07E-09
FBL	EIF3H	0.600	4.40E-42	5.67E-41	0.449	1.15E-13	6.82E-12	0.432	7.03E-09	1.59E-07
FBL	EIF6	0.743	2.73E-74	2.16E-72	0.449	1.19E-13	6.98E-12	0.411	4.10E-08	7.62E-07
FBL	ETFDH	-0.678	2.42E-57	7.24E-56	-0.410	1.91E-11	6.63E-10	-0.452	1.10E-09	3.01E-08
FBL	ETNPPL	-0.587	5.81E-40	6.63E-39	-0.452	7.20E-14	4.51E-12	-0.417	2.51E-08	4.94E-07
FBL	GPD1	-0.572	1.14E-37	1.13E-36	-0.470	5.87E-15	4.92E-13	-0.497	1.06E-11	4.81E-10
FBL	GYS2	-0.633	5.54E-48	1.02E-46	-0.501	4.20E-17	5.61E-15	-0.417	2.52E-08	4.96E-07
FBL	HAGH	-0.412	1.73E-18	5.91E-18	-0.466	9.53E-15	7.53E-13	-0.439	3.78E-09	9.04E-08
FBL	HAO2	-0.515	1.44E-29	9.22E-29	-0.480	1.28E-15	1.27E-13	-0.518	1.09E-12	5.98E-11
FBL	HMGA1	0.656	1.43E-52	3.39E-51	0.470	5.57E-15	4.70E-13	0.462	4.15E-10	1.30E-08
FBL	HNRNPA3	0.552	1.15E-34	9.71E-34	0.475	2.82E-15	2.59E-13	0.496	1.31E-11	5.87E-10
FBL	HNRNPH3	0.420	2.76E-19	9.95E-19	0.407	3.00E-11	1.01E-09	0.409	5.02E-08	9.00E-07
FBL	HNRNPM	0.597	1.43E-41	1.79E-40	0.576	2.83E-23	8.99E-21	0.477	9.57E-11	3.56E-09
FBL	HSD17B6	-0.522	1.41E-30	9.53E-30	-0.446	1.81E-13	1.04E-11	-0.412	3.69E-08	6.96E-07
FBL	IGF2BP2	0.522	1.51E-30	1.01E-29	0.440	3.92E-13	2.06E-11	0.450	1.32E-09	3.56E-08
FBL	ILF3	0.608	1.36E-43	1.90E-42	0.429	1.74E-12	7.77E-11	0.463	3.81E-10	1.21E-08
FBL	IMPDH2	0.809	8.39E-98	1.80E-95	0.732	1.05E-42	2.17E-39	0.511	2.41E-12	1.24E-10
FBL	IPO4	0.734	1.27E-71	8.79E-70	0.456	4.45E-14	2.93E-12	0.442	2.79E-09	6.87E-08
FBL	LRRC1	0.545	1.28E-33	1.01E-32	0.433	1.05E-12	5.01E-11	0.420	2.03E-08	4.07E-07
FBL	NAT10	0.594	3.90E-41	4.75E-40	0.426	2.54E-12	1.08E-10	0.575	6.96E-16	6.77E-14
FBL	NCL	0.567	9.00E-37	8.36E-36	0.521	1.31E-18	2.30E-16	0.708	1.90E-26	9.00E-24
FBL	NLE1	0.737	1.09E-72	7.91E-71	0.497	8.56E-17	1.05E-14	0.459	5.89E-10	1.79E-08
FBL	NPM1	0.636	1.26E-48	2.42E-47	0.500	5.30E-17	6.78E-15	0.512	1.99E-12	1.06E-10
FBL	NSA2	0.562	4.85E-36	4.34E-35	0.501	4.10E-17	5.53E-15	0.476	1.07E-10	3.89E-09
FBL	PDCD11	0.595	2.94E-41	3.61E-40	0.510	9.90E-18	1.46E-15	0.730	8.59E-29	8.71E-26
FBL	PES1	0.763	1.24E-80	1.34E-78	0.495	1.13E-16	1.36E-14	0.632	8.17E-20	1.18E-17
FBL	PFKFB1	-0.485	5.60E-26	2.93E-25	-0.471	5.02E-15	4.29E-13	-0.429	8.98E-09	2.00E-07
FBL	POLR1D	0.558	1.58E-35	1.38E-34	0.434	9.65E-13	4.65E-11	0.410	4.67E-08	8.46E-07
FBL	PRMT1	0.752	3.47E-77	3.15E-75	0.500	5.14E-17	6.71E-15	0.404	7.57E-08	1.29E-06
FBL	RBM12	0.407	4.26E-18	1.43E-17	0.578	2.13E-23	6.94E-21	0.564	3.02E-15	2.71E-13

FBL	RPP30	0.715	1.75E-66	9.03E-65	0.444	2.34E-13	1.29E-11	0.414	3.29E-08	6.27E-07
FBL	RSL1D1	0.556	3.38E-35	2.93E-34	0.449	1.15E-13	6.80E-12	0.643	1.20E-20	1.99E-18
FBL	RUVBL2	0.799	1.18E-93	2.11E-91	0.576	3.30E-23	9.99E-21	0.555	1.07E-14	8.81E-13
FBL	SLC10A1	-0.570	2.29E-37	2.22E-36	-0.502	3.65E-17	5.03E-15	-0.427	1.10E-08	2.37E-07
FBL	SLC46A3	-0.606	3.15E-43	4.30E-42	-0.613	7.37E-27	3.66E-24	-0.521	7.69E-13	4.30E-11
FBL	SSB	0.550	2.84E-34	2.33E-33	0.512	6.41E-18	9.70E-16	0.550	1.87E-14	1.39E-12
FBL	TAT	-0.602	1.95E-42	2.57E-41	-0.453	6.46E-14	4.17E-12	-0.418	2.42E-08	4.79E-07
FBL	TPD52L2	0.694	3.64E-61	1.38E-59	0.441	3.78E-13	1.99E-11	0.454	9.06E-10	2.59E-08
FBL	TRIM28	0.805	3.29E-96	6.58E-94	0.597	3.22E-25	1.29E-22	0.443	2.61E-09	6.46E-08
FBL	TRMT1	0.735	6.75E-72	4.71E-70	0.451	9.00E-14	5.44E-12	0.471	1.69E-10	5.96E-09
FBL	WDR46	0.744	9.19E-75	7.48E-73	0.435	7.89E-13	3.87E-11	0.720	1.07E-27	7.62E-25
FBL	XRCC6	0.683	1.17E-58	3.75E-57	0.415	1.05E-11	3.95E-10	0.554	1.14E-14	9.31E-13
